IMAGE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed to an arrangement and to a method for processing a digitalized image as utilized and implemented in the framework of an encoding and decoding of a digitalized image.

Such a method and such an arrangement are utilized in the framework of an encoding and decoding of a digitalized image corresponding to one of the image encoding standards H.261 the publication by D. Le Gall, "The Video Compression Standard for Multimedia Applications", Communications of ACM, H.263 the publication by G. Wallace, "The JPEG Still Picture Compression Standard", Communications of ACM of MPEG2 the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK that are based on the principle of a block-based image encoding. According to the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, the method of a block-based discrete cosine transformation (DCT) is employed for block-based image encoding.

Another approach for processing a digitalized image corresponding to the image encoding standard MPEG4 is what is referred to as the principle of object-based image encoding, as known from the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK.

In object-based image encoding, a segmentation of an image master into image blocks ensues corresponding to objects occurring in a scene, and a separate encoding of these objects ensues.

Components of a standard arrangement for an image encoding, as also known from the publication by W. Niem, et al., "Mapping texture from multiple

Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, and of an image decoding can be derived from Figure 7.

Figure 7 shows a camera 701 with which images are registered. The camera 701 can, for example, be an arbitrary analog camera 701 that registers images of a scene and either digitalizes the images in the camera 701 and transmits the digitalized images to a first computer 702 that is coupled to the camera 701 or transmits the images to the first computer 702 in analog form as well. In the first computer 702, the analog images are converted into digitalized images and the digitalized images are processed.

The camera 701 can also be a digital camera 701 with which directly digitalized images are registered and supplied to the first computer 702 for further processing.

The first computer 702 can also be designed as an autonomous arrangement with which the method steps described below are implemented, for example as an autonomous computer card that is installed in a further computer.

What is to be generally understood by the first computer 702 is a unit that can implement an image signal processing according to the method described below, for example a mobile terminal device (mobile telephone with a picture screen).

The first computer 702 comprises a processor unit 704 with which the method steps of the image encoding and image decoding described below are implemented. The processor unit 704, for example, is coupled via a bus 705 to a memory 706 in which an image information is stored.

In general, the methods described below can be realized both in software as well as in hardware or partly in software and partly in hardware.

After the image encoding has ensued in the first computer 701 and after the transmission of the encoded image information via a transmission medium

707 to a second computer 708, the image decoding is implemented in the second computer 708.

The second computer 708 can have the same structure as the first computer 701. The second computer 708 thus also comprises a processor 709 that is coupled to a memory 710 by a bus 711.

Figure 8 shows a possible arrangement in the form of a schematic diagram of the image encoding or, respectively, image decoding. The illustrated arrangement can be employed within the framework of a block-based image encoding and -- also shall be explained in greater detail later -- can be employed in part within the framework of an object-based image encoding.

In the block-based image encoding, a digitalized image 801 is divided into what are usually quadratic image blocks 826 having a size of 8x8 picture elements 802 or 16x16 picture elements 802 and is supplied to the arrangement 803 for image encoding.

Coding information, for example brightness information (luminance values) and/or color information (chrominance values), is usually allocated to a picture element 802.

In block-based image encoding, a distinction is made between different image encoding modes.

In what is referred to as intra-image encoding, the digitalized image 801 is respectively encoded with the coding information allocated to the picture elements 802 of the digitalized image and is transmitted.

In what is referred to as an inter-image encoding, only a difference image information of two chronologically successive, digitalized images 801 is respectively encoded and transmitted.

The difference information is very small when movements of image objects are slight in the chronologically successive, digitalized images 801. When the movements are great, then a great deal of difference information arises that is

difficult to encode. For this reason and as known from the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, an "image-to-image" movement (motion estimate) is measured and compensated before the determination of the difference information (motion compensation).

There are different methods for the motion estimation and the motion compensation as known from the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK. What is referred to as a "block matching method" is usually utilized for the block-based image encoding. It is based thereon that an image block to be encoded is compared to reference image blocks of the same size in a reference image. The sum of the absolute differences of an encoding information that is respectively allocated to a picture element is usually employed as a criterion for a coincidence quality between the block to be encoded and a respective reference image block. In this way, a motion information for the image block is determined, for example a motion vector, this being transmitted with the difference information.

Two switch units 804 are provided for switching between the intra-image encoding and the inter-image encoding. A subtraction unit 805 wherein the difference of the image information of two chronologically successive, digitalized images 801 is formed is provided for the implementation of the inter-image encoding. The image encoding is controlled via an image encoding control unit 806. The image blocks 823 to be encoded or, respectively, difference image blocks are respectively supplied to a transformation encoding unit 807. The transformation encoding unit 807 applies a transformation encoding, for example a discrete cosine transformation (DCT), to the encoding information allocated to the picture elements 802.

In general, however, any desired transformation encoding, for example a

discrete sine transformation or a discrete Fourier transformation, can be applied for the image encoding.

Spectral coefficients (transformation coefficients) are formed by the transformation encoding. The spectral coefficients are quantized in a quantization unit 808 and are supplied to an image encoding multiplexer 821, for example to a channel encoding and/or to an entropy encoding. The quantized spectral coefficients are inversely quantized in an inverse quantization unit 809 and are subjected to an inverse transformation encoding in an inverse transformation encoding unit 810.

In the case of inter-image encoding, further, image information of the respective, chronologically preceding image are added in an adder unit 811. The images reconstructed in this way are stored in a memory 812. For simpler presentation, a unit relating to the motion compensation 813 is symbolically presented in the memory 812.

Further, a loop filter 814 is provided that is connected to the memory 812 as well as to the subtraction unit 805.

In addition to a transmitted image information 822, a mode index that respectively indicates whether an intra-image encoding or inter-image encoding was undertaken is also supplied to the image encoding multiplexer 821.

Further, quantization indices 816 for the spectral coefficients are supplied to the image encoding multiplexer 821.

A motion vector is respectively allocated to an image block 820 and/or to a macro block 823 that, for example, comprises four image blocks 820 and is supplied to the image encoding multiplexer 821.

Further, an information particular for the activation or, respectively, deactivation of the loop filter is provided. After transmission of the image information via a transmission medium 818, the decoding of the transmitted information can ensue in a second computer 819. To this end, an image decoding

unit 825 is provided in the second computer 819, this unit 825, for example, comprising the structure of a reconstruction loop of the arrangement shown in Figure 8.

The publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology discloses a shape-adapted transformation encoding is specifically applied in the framework of an object-based image encoding to edge image block or image blocks that contain only partially relevant encoding information. The edge image blocks encoded upon employment of a shape-adapted transformation encoding are characterized in that only the picture elements that are allocated to an object or, respectively, that comprise encoding information relevant to the object are encoded.

The method described in the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology is what is referred to as a shape-adapted Discrete Cosine Transformation (Shape-Adaptive DCT, SA-DCT).

Within the framework of an SA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do not belong to the image object are blanked out. A one-dimensional DCT is then initially applied to the remaining picture elements column-by-column, the length thereof corresponding to the number of remaining picture elements in the respective column. The resulting transformation coefficients are horizontally aligned and are subsequently subject to a further one-dimensional DCT in a horizontal direction with a corresponding length.

The rule of SA-DCT known from the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology proceeds from a transformation matrix DCT-N having the following structure:

$$\underline{DCT-N}(p,k) = \gamma *\cos\left[p*\left(k+\frac{1}{2}\right)*\frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the SA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} *[\underline{DCT-N}(p,k)]* x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in a horizontal direction.

Various methods for the presentation of an object on a picture screen are employed in computer graphics. One method for the presentation of a subject is what is referred to as texture mapping.

The publication by J.D. Foley et al., "Computer graphics: principles and practise" discloses such a texture mapping.

In the framework of texture mapping, a digital image that contains a brightness information (luminance values) and/or a color information (chrominance values) of the object to be presented is mapped onto a surface of a three-dimensional model of an object to be presented.

The three-dimensional model 301 of the object to be presented, the model 301 being shown in Figure 3A, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304

of a Cartesian coordinate system 305.

As shown in Figure 3B, what is referred to as a block-shaped structure map 306 is allocated to each triangle 303, as shown in Figure 3B, the map 306 being constructed of picture elements 307 that are arranged rectangularly or, respectively, block-like. A brightness information (luminance values) and/or a color information (chrominance values) is usually allocated to each picture element 307.

The brightness or color information is allocated to the triangle 303 such that an appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of a corner point 308 of the triangle 309 is defined by the indication of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is assigned to the structure map 306. The coordinates (u_i, v_i) 310 are usually normed.

Via a transformation rule (allocation or, respectively, allocation key), the corresponding point 310 in the appertaining structure map 306 is allocated to each corner point 302 of each triangle 303 of the three-dimensional model 301.

As shown in Figure 4, further, all structure maps 401 are combined into a digitalized image 402, what is referred to as a superstructure map 402, wherein the individual structure maps 401 are arranged row-by-row and column-by-column. As warranted, the structure maps 401, which contain encoding information relevant for the presentation of the object, must be supplemented with structure maps 404 that contain no encoding information that is relevant for the presentation of the subject.

In particular, however, the above-described method exhibits a disadvantage. The structure maps and the superstructure maps as well comprise picture elements that contain no brightness or color information relevant for the representation of the object.

When the superstructure map is encoded in the framework of an image transmission, then the data rate occurring in the transmission is unnecessarily increased by the non-relevant picture elements.

For improving the above method, a structure map is processed in the following way (see Figure 5):

Those picture elements 501 of a structure map 502 that contain picture elements of an encoding information relevant for the presentation of the object are transformed into a new triangular structure map 503 with picture elements 506 that are arranged in a predetermined shape -- usually a right triangle -- and in a predetermined size. The transformation is implemented such that the picture elements 501, which are corner picture elements 504 of the triangle 505, coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map.

In the scope of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain a brightness or color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus only comprises picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain brightness or color information relevant for the presentation of the object are arranged to form a new superstructure map 602.

To that end, respectively two triangular structure maps 601a and 601b are arranged to form a block-shaped structure map 603.

Further, all block-shaped structure maps 603 are grouped by rows and columns, a digitalized image being thus generated.

The publication by J.D. Foley et al., "Computer graphics: principles and practise" also discloses that such a superstructure map as generated in the

framework of a texture mapping is encoded and decoded in an image transmission.

The encoding and/or decoding of a superstructure map thereby usually ensues upon employment of a block-oriented transformation in the intra-image encoding mode, as was set forth above.

As implemented in the framework of a processing of a digital image, this procedure is not very efficient in view of a low data rate to be desired for a transmission or in view of a higher image quality.

SUMMARY OF THE INVENTION

The invention is thus based on the problem of specifying a method for processing a digitalized image and an arrangement for processing a digitalized image with which a more efficient processing of a digitalized image becomes possible.

The problems of the prior art are addressed by a method for processing a digitalized image with picture elements that contain an encoding information,

a) whereby the image is at least partially divided into image blocks;

b) whereby an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

wherein the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block. The problems of the prior art are also addressed by an arrangement for processing a digitalized image with picture elements that contain an encoding information, whereby a processor is provided that is configured such that the following method steps can be implemented:

a) the image is at least partially divided into image blocks;

b) an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

wherein the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the method for processing a digitalized image with picture elements that contain an encoding information, the image is at least partly divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one appertaining image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the arrangement for processing a digitalized image having picture elements that contain an encoding information, a processor is provided that is configured such that the following method steps can be implemented:
The image is at least partially divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one of the appertaining image sub-blocks, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block with

respect to the appertaining image block.

In the method, the appertaining image block may be subdivided into a plurality of appertaining image sub-blocks. The first value, the second value and the third value are respectively allocated to each appertaining image sub-block. The image blocks may be arranged in columns and rows and/or column numbers may be assigned to the columns and row numbers are assigned to the rows. The first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block. The appertaining image sub-blocks may exhibit a different shape than the appertaining image block. The image sub-blocks can comprise a triangular shape. Preferably, the triangular shape comprises a right angle. In the method, the appertaining image sub-blocks are modified such that the respective position of an appertaining image sub-block with respect to the appertaining image block is respectively identical. In a preferred embodiment, the method is utilized in the framework of an encoding of the image. The image sub-blocks are encoded upon employment of the encoding information and/or upon employment of the first value, the second value and the third value with a shape-adaptive transformation encoding. In one embodiment, a shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the encoding. Specifically, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the encoding. Further, a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the encoding. The method may be utilized in the framework of a decoding of the image. In particular, an inverse shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the decoding. Further, an inverse Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the decoding. In particular, an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the decoding. In the method, the image at least partly comprises triangular structure maps.

The foregoing method of a preferred embodiment provides that the appertaining image block can be subdivided into a plurality of appertaining image sub-blocks. The respective first value and the respective second value and the respective third value can be allocated to each appertaining image sub-block. The arrangement can be utilized in the framework of an encoding of the image. A shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the encoding. For example, an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the encoding. The arrangement can be utilized in the framework of a decoding of the image. An inverse shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the decoding. The inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the decoding.

In one development, which effects a simplification of the method, the image blocks are arranged in rows and columns and/or column numbers are assigned to the columns and row numbers are assigned to the rows. The allocation expediently ensues such that the first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block.

In another development, an image sub-block exhibits a different shape than the appertaining image block. Preferably, the shape of the image sub-block is a triangle that has a right angle. Such a shape of an image sub-block reduces the calculating outlay for a shape-adaptive transformation encoding.

The image sub-blocks are preferably combined to form the image. The image thus comprises only picture elements that contain encoding information relevant for an object.

It is also advantageous to modify the image sub-blocks such that the relative position of an image sub-block is respectively identical with respect to the

appertaining image block. A shape-adaptive transformation encoding can thus be applied in the framework of an encoding and/or an inverse transformation encoding can be applied in the framework of a decoding, being applied to all image sub-blocks of the appertaining image block.

One development is utilized in the framework of an encoding and/or decoding of the image.

It is thereby advantageous to encode the image sub-blocks with a shape-adaptive transformation encoding upon employment of the encoding information and/or upon employment of the first value, second value and third value and/or to decode the image sub-blocks with an inverse shape-adaptive transformation encoding. An efficient encoding and/or decoding of the image is thereby achieved.

A simplification derives when, in one development, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) for encoding and/or an inverse SA-DCT for decoding is/are employed.

A further simplification derives when a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) for encoding and/or an inverse TA-DCT for decoding is/are employed.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the invention is shown in the Figures and is explained in greater detail below.

Figure 1 shows an arrangement for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figure 2 is a flow chart that illustrates the procedure for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figures 3A and 3B show a triangular grid structure of a three-dimensional model with an appertaining structure map;

Figure 4 is a schematic illustration of a superstructure map;

Figure 5 is a schematic illustration of a transformation of a structure map onto a triangular structure map;

Figure 6 is a schematic illustration of a superstructure map composed of triangular structure maps;

Figure 7 is a functional block diagram of arrangement for image encoding or, respectively, image decoding with a camera, two computers and a transmission medium;

Figure 8 is a functional block diagram of an arrangement for block-based image encoding or, respectively, image decoding;

Figure 9 is an illustration of the resolution of the block-shaped structure map.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows an arrangement for an image encoding and an image decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

Figure 1 shows a camera 101 with which images of an object 152 are registered. The camera 101 is an analog color camera that registers images of the object 152 and transmits the images to a first computer 102 in analog form. In the first computer 102, the analog images are converted into digitalized images, whereby picture elements of the digitalized images contain color information of the object 152, and the digitalized images are processed.

The object 152 is arranged centered on an object carrier 153. The relative position of the object carrier 153 with respect to the camera 101 is permanently prescribed. By rotating the object carrier 153 around its center, the object 152 can

be moved such that the angle of view from which the camera 101 registers the object 152 changes continuously given an unmodified distance of the object 152 from the camera 101.

The first computer 102 is configured as an autonomous arrangement in the form of an autonomous computer card that is installed in the first computer 102, the method steps described below being implemented with the computer card.

The first computer 102 comprises a processor 104 with which the method steps of image encoding described below are implemented. The processor unit 104 is coupled via a bus 105 to a memory 106 in which image information is stored.

The method for image encoding described below is realized in software. It is stored in the memory 106 and is implemented by the processor 104.

After the image encoding has ensued in the first computer 101 and after a transmission of the encoded image information via a transmission medium 107 to a second computer 108, the image decoding is implemented in the second computer 108. Subsequently, a model of the object 152 is presented on a picture screen 155 linked to the second computer 108 upon employment of the decoded image information of the object 152.

The second computer 108 has the same structure as the first computer 101. The second computer 108 also comprises a processor 109, the processor being coupled to a memory 110 with a bus 111.

The method described below for the image decoding is realized in software. It is stored in the memory 110 and is implemented by the processor 109.

Figure 2 schematically shows the procedure for a processing of a digitalized image in the framework of an encoding and of a decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

This procedure for the encoding and the decoding is realized by the arrangement shown in Figure 1 and described above.

1st Step Registration of the Object (201)

Upon employment of the camera 101 as described in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, images of the object 152 are registered, said object 152 being rotated in its position relative to the camera 101 in predetermined rotational angles with the object carrier 153. The images are transmitted to the first computer 102 in analog form.

Before the implementation of the registration of the object 152, the camera 101 is calibrated, as described in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, whereby a spatial geometry of the arrangement as well as the exposure parameters of the camera 101, for example the focal length of the camera 101, are defined.

The geometry data as well as the camera parameters are transmitted to the first computer 102.

2. Digitalizing the Images (202)

The analog images are converted into digitalized images in the first computer 102 and the digitalized images are processed.

3. Image Processing (203)

The processing of the digitalized images 103 ensues according to the method of automatic three-dimensional modeling upon employment of a plurality of images of the object, as described in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging.

Two method steps are implemented in the framework of the method of automatic three-dimensional modeling upon employment of a plurality of images of an object:

In the first step of the method, a volume model 301 of the object 152 is determined with a method for determining a contour of an object in a digitalized image, as cited in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, upon employment of the camera parameters and of the digitalized images 103.

The volume model 301 of the object 152, as shown in Figure 3, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304 of a Cartesian coordinate system 305.

In the second step of the method, what is referred to as a structure map 306 is determined for each triangle 303 upon employment of the digitalized images 103 as well as of the color information contained in picture elements of the digitalized images 103.

The structure map is constructed of picture elements 307 arranged block-like. Each picture element 307 contains a color information (chrominance values) of the object 152.

The color information is allocated to the triangle 303 in that an

appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of the corner points 308 of the triangle 309 is determined by the specification of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is allocated to the structure map 306. The coordinates (u_i, v_i) 310 are subsequently normed.

Via a transformation rule, the corresponding point 310 in the appertaining structure map 306 is assigned to each corner point 302 of each triangle 303 of the three-dimensional model 301.

Those picture elements 501 of a structure map that contain a color information relevant for the presentation of the object 152 are transformed into a new triangular structure map 503. The picture elements 506 of the triangular structure map are arranged such that they form a right-angle and equilateral triangle, whereby one side comprises five picture elements. The transformation is implemented such that the picture elements 501 that are corner picture elements 504 of the triangle 505 coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map 503.

In the framework of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus comprises only picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain the color information relevant for the presentation of the object are arranged to form a new superstructure map 602.

To that end, respectively two triangular structure maps 601 are arranged to form a block-shaped structure map 603. Further, all block-shaped structure maps 603 are groups by rows and columns, whereby a digitalized image is generated.

Due to the uniform and predetermined shape of the triangular structure map, the row-by-row and column-by-column arrangement of the block-shaped structure maps 603 and a predetermined size of the superstructure map 602, a simplified transformation rule or, respectively, a simplified allocation key derives that is referred to as texture binding:

Each triangle 303 of the spatial triangular grid structure 301 of the three-dimensional model of the object 152 has allocated to it a first value n_S that indicates the column number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, a second value n_Z that indicates the row number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, and a third value n_L that indicates the relative position of the triangular structure map 601a or, respectively, 601b with respect to the block-shaped structure map 603.

Upon employment of the value triad (n_S, n_Z, n_L) indicated for each triangle 303 of the spatial grid structure 301 and of the given values in view of the height H (plurality of picture elements, for example 80 picture elements) of the superstructure map having the size HxB and of the given plurality of picture elements Z arranged in a side of the right equilateral triangle with, for example, Z=5 picture elements, an allocation of a triangular structure map 601 of the superstructure map 602 to the appertaining triangle 303 of the volume model 301 of the object is determined according to the following relationships:

$A_x = (Z/B) * (n_S-1)$

$A_y = (Z/H) * (n_Z-1)$

$B_x = (Z/B) * n_S$

$B_y = A_y$

$C_x = B_x$

$C_y = (Z/H) * n_Z$

$D_x = A_x$

$D_y = C$

The corner picture elements (Ax,Ay), (Cx,Cy) and (Dx,Dy) are relevant for the value nL = 0 that describes a triangular structure map 601a arranged at the left within the block-shaped structure map 603.

The corner points (A_x,A_y), C_x,C_y) and (B_x,B_y) are relevant for the value n_L = 1 that describes a triangular structure map 601b arranged at the left within the block-shaped structure map 603.

The two values that are identified by the index x and by the index y thereby indicate the coordinates of a point of the superstructure map 602 with respect to a Cartesian coordinate system 610 that is arranged in the upper left corner 611 of the superstructure map 602.

4. Encoding (204)

What is referred to as a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is employed for the encoding of the superstructure map 602. This method for encoding a digitalized image is based on the method of a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) as described in] the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology.

In the framework of a TA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do nor belong to the image object are blanked out. A one-dimensional DCT, whose length corresponds to the number of picture elements remaining in the respective column, is then first applied column-by-column to the remaining picture elements. The resulting transformation coefficients are subsequently subjected to a further one-dimensional DCT in horizontal direction with a corresponding length.

The method of TA-DCT proceeds from a transformation matrix DCT-N

having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the TA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT-N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in horizontal direction.

In the framework of the encoding of a superstructure map 602 upon employment of TA-DCT, the superstructure map 62 is subdivided into the block-shaped structure maps 603. A block-shaped structure map 603 and 901 is thereby divided into a first new block-shaped structure map 902 and a second new block-shaped structure map 903, as shown in Figure 9, in that the picture elements of the second triangular structure map 601b and 904 are deleted for the determination of the first new block-shaped structure map 602. The second new block-shaped structure map 903 is determined in that the picture elements of the first triangular structure map 601a and 905 are deleted.

Further, the second new block-shaped structure map 903 is modified such by shifting picture elements 906 that the relative position of the picture elements 906 of the second block-shaped structure map 903 with respect to the second new

block-shaped structure map 903 coincides with the relative position of the picture elements 907 of the first new block-shaped structure map 902 with respect to the first new block-shaped structure map 902.

The TA-DCT can thus be correspondingly applied to the first new block-shaped structure map 902 and to the second new block-shaped structure map 903.

The TA-DCT can be utilized due to the specific relative position of the picture elements 906 and 907 with respect to the first new block-shaped structure map 902 and the second new block-shaped structure map 903.

5. Transmission (205)

The image information (image information of the superstructure map) encoded upon employment of the TA-DCT is transmitted via a transmission medium 107 to the second computer 108 together with data of the volume model of the object as well as of the allocation $(n_S, n_Z, n_L)_i$ ($i = 1 \ldots N$, with N = number of triangles of the grid structure of the volume model).

6. Decoding (206)

An image decoding is implemented after transmission of the encoded image information.

To that end, the spectral coefficients c_j are supplied to an inverse TA-DCT.

Given inverse TA-DCT in the framework if image encoding in the intra-image encoding mode, picture elements x_j are formed from the spectral coefficients c_j according to the following rule (4):

$$x_j = \sqrt{\frac{2}{N}} * [\underline{DCT-N}(p,k)]^{-1} * c_j \qquad (4)$$

whereby the transformation matrix $\underline{\text{DCT-N}}$ comprises the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

whereby

-- N references a size of the image vector to be transformed wherein the picture elements to be transformed are contained;

-- [DCT-N (p, k)] references a transformation matrix having the size NxN;

-- p, k reference indices with p, k ∈ [0, N-1];

-- $( )^{-1}$ references an inversion of a matrix.

The decoded image or, respectively, the superstructure map 602 is determined upon employment of the determined picture elements x_j.

7. Presentation of the Object (207)

The model of the object 152 is presented on the picture screen 108 upon employment of the superstructure map, the data of the volume model of the object 152 as well as the allocation$(n_S, n_Z, n_L)_i$ (i = 1 ... N, with N = number of triangles of the grid structure of the volume model), as described in the Internet publication PANORAMA technical Support, available on 12 October 1998 at: http://www.tnt.uni-hannover.de/project/eu/panorama/TS.html.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.